

REMARKS

Favorable reconsideration of this application in light of the following discussion is respectfully requested.

Claims 112, 114, 116, 118, 121, 122, 124, 126, 128, 131, 133, and 135-138 are presently active in this case, Claims 112, 114, 116, 118, 120, 121, 124, 126, 133, 136 and 137 having been amended, and Claims 113, 115, 117, 120, 122, 123, 127, 132 and 134 canceled and Claim 138 is added by way of the present amendment.

In the outstanding Official Action, the Abstract was objected to; the claims were generally rejected under 112, first paragraph; Claims 120 and 137 were rejected under 112, first and second paragraphs; Claims 112-118, 120-124, 126-128, 131-137 were rejected under 112, first paragraph; Claims 112-118, 121-124, 126-128, 131 and 133-136 were rejected under 35 U.S.C. §103(a) as being unpatentable over under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,847,111 to Chow et al. in view of Park et al.; Claims 115, 123 and 127 and 134 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chow and Park, and further in view of Hatano et al.; Claims 117, 135 and 136 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chow and Park and further in view of Buyn et al.; Claims 120 and 137 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chow and Park and further in view of Fleming et al.; Claims 122 and 132 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chow singly or with Park and further in view of Yelverton et al..

With regard to the objection to the Abstract, submitted herewith is a new Abstract on a separate page. Therefore, the objection to the Abstract is believed to be overcome.

With regard to the rejections under 35 U.S.C. §112, first paragraph, in order to expedite issuance of a patent in this case, the step of “evacuating the processing vessel” has been deleted from the claims. In place of this limitation, the expression “while a predetermined processing pressure in the processing vessel is maintained” has been added to the structural element (b) of the claims. This expression is fully supported by the description provided in the specification, page 16, line 19. In this regard, Applicants note that although the description provided in page 16 is directed to one-step formation, the specification as a whole makes clear to one of ordinary skill in the art that the conditions of one step formation can be applied to two step formations as well. Moreover, Applicants note that the step of “(c) shutting off” is supported at least by the description provided in page 20, line 5, and the step of “(d) removing the process gas” is at least supported by the description provided in page 20, line 20 to 21. By these Claim changes and explanation, Applicant submit that the rejection under 35 U.S.C. § 112, first paragraph is overcome.

With regard to the rejection under 35 U.S.C. § 112, second paragraph, Claim 120 has been canceled and Claim 137 has been amended to correct the informalities noted in the Official Action. Therefore, the rejection under 35 U.S.C. § 112, second paragraph, is believed to be overcome and no further rejection on this basis is anticipated. If, however, the examiner disagrees, the examiner is invited to telephone the undersigned who will be happy to work with the examiner in an effort to provide mutually satisfactory claim language.

Turning now to the prior art rejection, in order to expedite issuance of a patent in this case, Applicants have amended the claims to clarify the patentable features of the present invention. Specifically, Claim 112 recites the following 3 features:

1. In step (b), the WSi film is formed by CVD;
2. In step (e), the Wsi film is nitrided by a plasma-free thermal process; and
3. The step (d) is inserted between the above steps (for the reason described in, for example, page 26, lines 8 to 20).

Independent Claims 121, 126, and 131 include a similar sequence of steps.

The gases used in the nitriding step are NH₃, MMH and N₂. Of these, the NH₃ gas and MMH gas have more reducing properties than that of the N₂ gas, and therefore it is possible to carry out nitriding without using plasma. Therefore, in the embodiments of the present invention, plasma is used when the N₂ gas is used, whereas when the NH₃ or MMH gas is used, the nitriding is carried out by a heat process. In order to clarify that the nitriding process with plasma is not carried out, the step (e) of independent Claims 112, 121, and 126 is limited to using the NH₃ gas or MMH gas, and independent claim 131 is limited to using NH₃ gas. Moreover, the processing temperature is limited to 300 to 450 °C in dependent Claims 116, 118, 128, 136 and 137. Generally, plasma is not generated in such a low temperature range.

In contrast, in the Chow reference, the nitriding is carried out with the plasma using the N₂ gas (at a temperature of 676 °C). With this method, nitrogen ions and nitrogen radicals created by the plasma have very weak reducing properties and therefore the nitriding efficiency is poor. When this method is carried out under normal conditions, only a surface portion of the W film can be formed. In the present invention, in order to nitride the entire W film, the step (e) is carried out. Further, in Chow, tungsten nitride and tungsten silicide layers are formed from the W film at the same time by utilizing the characteristics of the plasma

using the N₂ gas. By contrast, in the present invention, a tungsten silicide layer is not formed in the step (e) of Applicant's independent Claims 112, 121, 126 and 131.

With regard to Park, in this reference the pressure is set lower before the introduction of WF₆ gas and/or NH₃ gas, that is, before the film formation. By contrast, in the present invention, the step (a) is carried out before the film forming step (b). Further, in Park, a tungsten nitride film is formed by one step without previous formation of a WSi film. This method corresponds to the one step formation described in the first and second embodiments of the present invention. In the one-step formation, by-products are apt to generate during the process, so that the formed tungsten nitride film has a poor quality.

For the reasons discussed above, Claims 112, 121, 126 and 131 patentably define over the combination of Chow and Park. Moreover, Applicants note that the secondary references to Hatano et al., Buyn et al., Fleming et al., and Yelverton et al. were cited in the Official Action for teaching limitations of the dependent claims and do not correct the deficiencies of Chow et al. and Park et al. noted above. Therefore, as the pending dependent claims depend from the independent claims distinguished above, these dependent claims also patentably define over the cited references.

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Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application, and the present application is believed to be in condition for formal Allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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